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ABSTRACT

Two classroom case studies are used to investigate common concerns about the use and value of Science-Technology-Society (STS) themes as curriculum organizers. The author discusses the fear that a focus on STS may de-emphasize science concept learning in the overall curriculum, and suggests that this may be appropriate at the middle school level. The efforts and commentary of two teachers of seventh grade life science at different middle schools in the same large suburban district are compared and contrasted. Each teacher is constrained by conservative curriculum guidelines. One teacher chooses to adhere to the guidelines and implement STS activities in an ad hoc manner, while the other conducts a student-centered interactive STS activity. Excerpts from class discussions are provided. It is concluded that the STS activity did not result in open and critical thinking on the part of the students but rather gave students a low-level factual expertise. The author suggests that teachers should be conscious of making value judgments about their curriculum, rather than uncritically accepting broader claims for the value of STS organizers in addressing a wide variety of science learning objectives. (LZ)

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Two cases of Implementing STS Activities in the Context of a Traditional Middle School Life Science Curriculum: Same Rules, Different Games

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Contribution to a roundtable session presented at the annual meeting of the National Association for Research in Science Teaching, April 15, 1993, Atlanta, GA.

Research perspective: acknowledgment of biases

The perspective I bring to this effort is that of "devil's advocate" on behalf of those who are skeptical about the value of the use of Science-Technology-Society (STS) themes as curriculum organizers. While the theoretical value of linking science with social and technological issues is highly appealing in many ways, I share with many traditional science teachers the fear that a major focus on technological applications and social issues application might "water down" the science content when put into practice, e. g., as one teacher complained,

> It's mostly social studies with a little science thrown in....There's not enough meat....I see science as the teaching of principles and concepts, not the social skills....It's all fun-and-games stuff. (cited in Mitchener & Anderson, 1989, p. 363-364)

In this view the extensive use of an STS focus may only be justified based on a conscious decision to de-emphasize science concept learning in the overall curriculum, e. g., as one teacher put it,

> The...curriculum's focus is on decision making, group skills, and science/social studies applications, rather than strict science content...We're after interaction and critical thinking: just having two

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> opposing views about something we discussed. (cited in Mitchener & Anderson, 1989, p. 357)

My preconceived view is that this may well be appropriate at the middle school level. Indeed, it well describes my own philosophy towards college students' learning in science education courses. Teachers, however, should be conscious of making such a value judgment about their curriculum, rather than uncritically accepting broader claims for the value of STS organizers in addressing a wide variety of science learning objectives.

Research perspective: Focus

The two teachers whose efforts and commentary will be compared and contrasted here teach seventh grade life science at different middle schools in the same large suburban district. Two documents, adopted in 1989 and disseminated by the district to its middle school science teachers are highly relevant to this study. The district's "Philosophy of Science Education K-12" is explicitly labeled as a modified version of the NSTA's (1982) Position Statement on STS. Both documents begin:

> The goal of science education is to develop scientifically literate individuals who understand how science, technology, and society influence one another and who are able to use this knowledge in their everyday decision-making. (p. 2)

The other district document in question is a set of curriculum guides for each middle school grade, of which the seventh grade life science volume runs to well over 400 pages. This vast collection of concept- and process skills-oriented objectives and lesson ideas contains none of either which suggests a distinct STS focus.

Thus, superficially, these two teachers have the same institutional and bureaucratic resources and responsibilities, freedoms and constraints. Both are widely acknowledged, by students and by university faculty who know them well, to be outstanding science teachers. The demographic characteristics of the student populations at the two schools are significantly different, but neither teacher indicated that this was a major consideration in their thinking about implementing STS activities into their science teaching. Differences in their attitudes, perceptions, and personal styles, however, contributed to tremendous differences in their implementation of what they learned in the summer STS course experience.

Results: Judy

Judy teaches at a school in a part of the suburban district that is relatively densely populated and relatively close to a major city. The student population is rapidly growing more culturally diverse. According to demographic information gathered for an unrelated study (McGinnis, 1992), students at the school and in Judy's classes are generally from a "middle to lower class" background and include approximately 15-20% African Americans and 15-20% international students. Judy lives in a suburban setting about 10 miles from the school.

Judy has a very well-developed and carefully considered philosophy of teaching in general and of middle school science teaching in particular (for a more detailed analysis see McGinnis, 1992). She considers herself a lifelong learner, a teacher who adopts truly new ways of teaching throughout the course of her career in response to changing conditions. She specifically singles out as "scary" those of her colleagues who preach

change and innovation but do not put it into practice. Judy's explicit philosophical guidelines fit very well with a shift towards an STS emphasis in curriculum. Her core commitment is to emphasize "basic knowledge as it relates to the students and to their own realm of personal experiences...You can get along without information or content....[More important is the] need to get along with different people" (cited in McGinnis, 1992, pp. 121, 122).

Judy considers herself among a very small proportion (she estimates 2%) of science teachers who truly "know their stuff," as opposed to "pseudo-science teachers" who do not have a deep understanding of the concepts and principles underlying the more superficial "facts" of science. Life science, she believes, is not an artificial or arbitrary division of the curriculum, but a distinct and well-defined body of knowledge of which she is confident in her own mastery. Judy sees this not as a rationale for narrowing her curriculum horizons, but as a license for innovation: "[I am] not going to be tied to a curriculum, but you take someone who does not have the science background, that becomes their Bible, that becomes their only means of survival" (cited in McGinnis, 1992, p. 144)

When asked about her past experiences in which she has tried innovative methods of teaching, she has thus far had only pleasant experiences. The various "off the wall" activities, as she describes them, have generated no negative reaction from parents, for instance, except for those (primarily foreign) who might think that cultivating individual judgment and critical thinking is generally undesirable. "And after all," she says with a sigh and a resigned laugh, "you don't have to have ever left [the state] to feel that way."

A sticking point for many teachers in including STS activities is that they often include consideration of dilemmas for which there is not a clear solution or a even a readily identifiable majority view. If a teacher adopts some version of a relativist epistemology is order to embrace a topic of this nature, how can the students be evaluated on their learning? Judy largely dismissed these as problems. A distinct closure or consensus is not required, she reasons, but rather what is important is that "each kid comes to conclusions and respects those that others come to." Evaluation, it seems, would not discourage her from using some such STS activities, either: "I could judge whether or not they had gotten it by whether they can support their arguments."

An STS curriculum which emphasizes student-centered activities such as structured controversy regarding current issues (as modeled often in the summer course) could, in the mind of the skeptic, have two additional drawbacks. One is the perception that the level of thinking skills needed for researching an issue and weighing the merits of possible solutions makes STS activities best suited to advanced and/or gifted students, rather than typical middle schoolers. Judy denies this. In fact, she argues that the motivational value of STS would be diminished: "Gifted kids have a natural motivation, so they don't need change of format just for that reason." In fact, however, "about two-thirds" of Judy's students *are* gifted, and this may present both additional opportunities and problems -- "They bring up topics all the time. I envision STS things popping up rather than planning topics in which to do it."

This raises a second possible problem -- might the ad hoc nature of these student suggestions make planning more difficult for her? In general, no: "I can handle coming up with plans on short notice, no problem. We could

use outside current issue articles, which students may suggest, or TV programs. I have shown TV programs when they come up (as opposed to when they fit into the curriculum) before."

After negating almost all of the possible barriers to implementing STS activities in her classes, Judy finally acknowledged one problem, which tended to make all of her intentions a moot point -- the specified curriculum of the district for her grade and subject. The county curriculum has "specific deadlines here and there" which operationally define a coherent notion of scope and sequence. The first months are designed to lay the foundations or "building blocks" for future studies. Judy does not feel that the curriculum is "a document that is handed down to the teacher" (Tippins, this session, p. 32), because she had a hand in its design: "I know, I was on the committee that accepted them -- they're important." In her mind, although she considered herself more than competent to make curriculum decisions, she accepts the essentially conservative nature of the school district's values as a real and justifiable constraint: "'Hands-on, but cover the topics' is the mandate." When asked if any particular individual would be "checking up" on her in this regard, she replied that she expected both her principal and a supervisor to do so.

In addition, several life science topics with strong implications for social policy and connection to technological issues are specifically forbidden, either explicitly or implicitly, by the curriculum (see McGinnis, this session). HIV and AIDS, for instance, may only be substantively addressed by health education teachers, rather than science teachers ("I guess I've never seen it in writing, but we got that message clearly").

Judy's ultimate conclusion was a commitment to any long-term project-oriented work on STS themes was inconsistent with her obligations:

> Some topics can be worked in, but there's no time to do it on a large scale -- a day here and there, 45 minutes here and there, I can see that. 3 weeks to solve a problem, no. STS is not an organizer for an entire year -- we *could* potentially write the curriculum along those lines, but that would be stupid unless everyone [other teachers] were trained.

In fact, the extent of Judy's STS activities during the year was to show several topical videotapes within a week of their showing as PBS programs, then leading an open discussion afterwards.

Results: Bob

Bob teaches at a school in a part of the suburban district that is relatively sparsely populated and relatively far from a major city. The student population is racially/ethnically quite homogeneous, with very few minority students. In terms of socioeconomic status, however, students at the school and in Bob's classes come from a wide range (and a somewhat bimodal distribution) of backgrounds. The school is located in a semi-rural area in which rapid new homebuilding is bringing in an increasingly affluent, well-educated and metropolitan-oriented population. While many students are children of professionals, there is a concentration of disadvantaged households large enough to warrant a Head Start center only a block away from the school. Bob lives in a different semi-rural area, near a small city, about 30 miles away from the school.

Like Judy, he also teaches seventh grade life science. Like Judy, Bob served on several committees which crafted and/or approved the district's extensive curriculum documentation. Like Judy, the idea of an STS unit centered on a "hot topic" like AIDS jumped to his mind, but faced several potential problems. Unlike Judy, Bob threw curricular caution to the wind and forged ahead.

In order to address the specific curriculum objective regarding viruses, he researched the scientific and public policy literature and discovered an acceptable stand-in for AIDS: a viral disease of cattle known as bovine spongiform encephalitis (BSE or "Mad Cow Disease"). This imperfectly understood infection disables and eventually kills an animal by attacking clusters of neurons so as to lend a visibly porous texture to the brain. It is, as of yet, confined to Great Britain, but there are fears that it might affect beef-consuming humans in some way and that it might enter and spread throughout the America.

Bob allocated two weeks of class time for his students to do library research and hold small-group discussions in preparation for giving and hearing "expert testimony" at a mock "congressional hearing" regarding what steps, if any, the U. S. Government can or should take to protect the population and the cattle industry in this country. He placed his trust in the notion that "We need to make it real, in order to get them involved -- although it may sound obscure, they'll remember this a lot longer than they would remember reading or hearing from me about whatever, exactly, a virus is, et cetera."

The culminating structured controversy activity which I observed was in fact very lively and held the interest of nearly all of the students. What effect did it have on their understanding of scientific, technological, and/or social principles and concepts? Following a practice highly recommended in the summer course, he scheduled a debriefing session the following day. The following vignettes drawn from a transcript of that session strongly suggest that the students did not very well understand the point of the activity.

Bob: I would like to see through what we've just been doing and see what effect it's going to have on the future activities we have in here and also try to process this information, we'll see how it fits into real life. Let's start with looking at the process altogether -- this was a congressional hearing, that's what were trying to imitate here. How do you think our activity was different from a real congressional hearing? Yes, M?

M: Well, first of all, we were confined to just a short period of time...

E: Mostly, nobody would be screaming, "Be quiet" -- they'd be able to throw out people who misbehaved....

Bob: Let's think about this whole process for sharing information, for collecting information. Now, if you are trying to get information as a congressperson on a serious problem like BSE, is a hearing a good way to get information, to compare information, how do you feel about that after trying to work with this for a couple of days?

K: They say all these different things bad about your group and things

Bob: And you have to just sit there and take it, right?

K: Yea, you can't talk back right away and then you forget what you were going to say to them...

Bob: So you'd like more of a debate?

C: I think it's fair to have hearings 'cause everyone gets to say what they believe...

Bob: and they can be heard, their total testimony can be heard at one time, and they're not interrupted.

M: Well, you've got freedom of speech, so you could interrupt them at any time.

The general pattern that I observed was that every one of the students did, in fact, get to say what they believed. There was very little sign, however, that any could back up their statements and opinions on social and policy issues by using scientific knowledge or technological insights.

It became clear that one of Bob's goals was to convey the importance of scientific evidence to decision-making:

Bob: Think about the different roles that you had to play -- why did these people have different points of view? What was it that created the different points of view among different groups? Why did the different point of views exist? Why did these opposite or variety of perspectives on this issue, why did they exist to begin with? Where did it come from?

M: [restates his point of view on a particular aspect of the BSE issue]

Bob: Ok, but where did that view come from?

M: [restates his point of view again]

Bob: Let's isolate this point, here though. Why do people have different points of view? Why do we not all look at the issue in the same way? Why do we have so many people with different opinions in this country and other places?

D: Here or everywhere?

Bob: anywhere

D: Well, anywhere, maybe its their beliefs, or how they see the situation. Here it's because you *told* us what we think...

Bob: That's true, in the class, I *gave* you a viewpoint. And in a real congressional hearing we'd have a variety of viewpoints. *Why?* Why do people have different opinions?

A: Because of their group, and the kind of people they're around, and what's good for them. I mean, if they're cattle ranchers they're not going to say get rid of the meat. The people they have to deal with each day, their occupation or something.

K: Even if you've grown up the same way, you might have different opinions, different values.

Bob: Or, like some of you found out, it could be like, killing animals for our consumption, that could be more of value or moral issue...

Several of the students seem to have accepted a relativist view of hearings/debates as searches for truth or justice. If this is an important objective of this science class activity, then it was visibly successful. Bob did not stress this at all in a pre-activity interview, however, preferring to emphasize the motivational value of the STS activity for science learning.

Bob continued to rephrase the question, trying to draw out of the students some understanding and make them realize why the whole enterprise is relevant:

Bob: Now, let's bring this to a more serious stage in our discussion. What would happen, what do you really think would happen (I'm not asking you to follow a role here). I'm asking you to think about your own personal situation, your own judgment on what you know, what do you think would happen if BSE actually did enter the country and enter the food supply. What do you think would be the outcome, from what you have learned and discussed to this point?

E: It would cost hundreds of millions of dollars...the workforce, all the money in the cattle...

Bob: Do you think the scientific institutions in this country are worried about this? Do you think we have a lot of research going on right now on this?

Bob: Let's look at it another way. let's not think of this one disease that may or may not enter the United States. Are there other types of virus problems, bacteria problems, that could affect us in the future, do you think this is isolated. Is it true that what happened before will never happen again? What impact does this have for other diseases, especially viral diseases?

M: You know how cows have other diseases, and it might spread to other animals, and we could eat them...

Bob: Yes, that's one concern we have about BSE, but what if BSE fizzles out, if we never see it again. Can we learn anything from it? Anything that it teaches us about how viruses can affect us?

[specific debate between M and K: money spent versus small number of infected cows eliminated]

Bob: M and K, this is just going back to the debate, not really answering the question. Can you think of another example of a virus disease that just sort of popped up out of the blue as far as the public was concerned, and suddenly became a threat?

A: Oh, AIDS.

Bob: OK, AIDS has not been around all that long. it's also caused by a virus. 10-12 years ago, people didn't know that much about it, whether it was going to be a big problem or not, and now we know that it is an immense problem.

G: Anthrax...

Bob: Yes, anthrax is another disease of cattle, which can also affect human beings.

G: Well, koro [sic], or whatever it was, that affects cannibals, so it could be eliminated. But with cows, well, it will always pop up somewhere. I mean, if you say, kill all the cows, it might show up in another animal somewhere else.

[Madam chairperson's final report of recommendations is then read in its entirety]

In general, the students seemed unable to abstract or generalize from the experience. Their research had given each of them some factual expertise in a few areas, but they were not thinking openly and critically about the arguments made by others in the "hearing." The student-centered, interactive structure of Bob's unit made it enjoyable for most all of the students, but it seems to have produced a familiar result -- largely inert, low-level, factual knowledge.

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